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INTRODUCTION

Mass windthrows are generally regarded as menacing to living timber because of the subsequent development of bark beetle infestations. They occur rather infrequently as a result of high velocity winds and the areas covered may vary from a few hundred to several thousand acres. In nearly all cases they have been found to serve as breeding places for destructive bark beetles.

The most recent case occurred in ponderosa pine stands in the vicinity of McLeod Flat near Bass Lake, Madera County, California. This area was subjected to a severe east wind of hurricane velocity during January 1944. Winds of this character, known locally as "Mono Winds" occur one or more times each year, ordinarily in the spring or fall. This January blow, at a time when the ground was soaked by heavy rains, resulted in a windthrow which affected an estimated 20 to 40 percent of the stand. Parts of the area as viewed from the Beasore Road during the early summer in 1944 were reminiscent of a recent logging operation.

Our chief interest in this blowdown lay in the influence that the large number of prostrated trunks partially rooted to the ground would have in the up-building of a bark beetle infestation. The situation was early recognized as an insect hazard because of the probability that the downed logs would serve as ideal breeding places for the western pine beetle and Ips. Those hazards were also recognized by the Forest Service who initiated salvage through sales to a local North Fork sawmill. This operation, however, was not begun until late in the fall of 1944 and only the logs within easy access of the Beasore Road were taken.

No detailed studies of this blowdown in relation to subsequent infestations were made, but enough positive information was secured to establish another case record of a menace which cannot be regarded lightly. The subsequent effects of the blowdown came much as anticipated during 1945 with D. brevicomis prominently out in front. This report is intended to present a recapitulation of events from the time of the blowdown to the development of epidemic conditions by the western pine beetle. It is further intended to call to mind the necessity for quick action to remove a hazard which if left is almost certain to result in destructive killing of merchantable timber.

PREVIOUS EVIDENCE ON THE HAZARDS OF BLOWDOWNS.

Miller's[1] account of two mass blowdowns within the California pine region and their subsequent effect in causing bark beetle epidemics is the only published record on this subject. The positive relationship as shown in these two outstanding cases has been substantiated in practically every case since then where blowdowns have been concerned. The current McLeod Flat blowdown is the third mass windfall of which there is a record of subsequent bark beetle damage in the California pine type.

Outside California the most recent record of mass blowdowns and bark beetle epidemics is in Colorado where a severe blowdown in 1939 resulted in the worst Engelmann spruce beetle epidemic on record, beginning in 1943.

Much of the beetle losses in the Oregon and Washington pine type during 1932 and 1933 resulted from breeding in blowdowns which occurred in April 1931. According to Buckhorn[2] "On April 21-22, 1931, a northeast wind of cyclonic violence swept over the eastern portions of Oregon and Washington. Damage to forests varied considerably. The greatest damage on the Ochoco National Forest occurred on the Prineville, Ochoco Creek and Maury Mountain Areas. Crests of northeast exposures were hardest hit, in some instances practically leveling the stand." In the Yakima Indian Reservation of Washington State Keen[3] reported that "following the 1931 windstorm which blew over as much as 25 percent of the timber stand on some sections of the Cedar Valley unit, the beetles breeding in this material emerged and started an aggressive epidemic in the standing timber. Two sections checked by timber cruisers of Brown & Brown Company showed additional losses of 20 and 28 percent of the stand due to beetle attack - - ."

Almost every year there are localized blowdowns in certain of the forested areas. The scattered character of these logs through the woods tends to minimize their importance as breeding places for bark beetles. The facts are, however, that while the separate trees do not breed populations sufficient to cause a virulent type of epidemic, they do increase to an appreciable degree the number of killed trees within the locality of the windthrows and because of this they too must be regarded as menacing to living timber. The Signal Peak blowdown in cutover reserve sugar pine and the subsequent development of a D. monticolae outbreak in 1937, reported by the writer[4] is one such example; but there are many others of which we have no formal record.

1/ Miller, J. M. 1929. The Relation of Windfalls to Bark beetle Epidemics. IV International Congress of Entomology, Ithaca; August 1928. Volume II.
2/ Buckhorn, W. J. 1939. Report of Pine Beetle Surveys on the Ochoco National Forest, 1931-1937.
3/ Keen, F. P. 1934. Annual Report of Forest Insect Conditions in Oregon and Washington.
4/ Struble, G. R. 1937. Signal Peak Insect Control Project, Sierra National Forest. Berkeley, California

DESCRIPTION OF THE MCLEOD FLAT BLOWDOWN AREA.

McLeod Flat is situated two miles due north of The Pines resort at Bass Lake on the Sierra National Forest. The affected area covered approximately 500 acres in parts of sections 2, 3, 10, and 11; T.7S.; R.22E. Ponderosa pine is the principal timber type in mixture with incense cedar and some white fir and sugar pine. Black oak, interior live oak, manzanita, and chaparrall (Ceanothus cuneatus) are the principal understory species. The soil is decomposed granite and is shallow, but supports a good stand of site III-IV quality timber. The slopes are for the most part gentle and extend to the west. The elevation is approximately 3,500 feet.

INFESTATION CONDITIONS AT THE TIME OF THE BLOWDOWN.

During the eight-year period prior to the 1944 blowdown, the Bass Lake area remained relatively free from the menace of bark beetles. This was due in part to a natural decline in beetle populations generally, and to continuous annual maintenance control work undertaken in this area by the Forest Service following the epidemic of 1932. The entire area at the time of the blowdown contained an inconspicuous number of infested trees which were not considered hazardous. It is probable, however, that this relatively small number served as the nucleus from which broods developed in great numbers later in the blowdown material at McLeod Flat.

GENERATIONS INCLUDED IN THE OUTBREAK.

While we do not have all the facts with regard to the number of generations that developed in windfalls before the onslaught against living timber or of the progressive upbuild in populations, it is possible on the basis of past records and experience to recapitulate events leading up to the outbreak. On the basis of previous knowledge we have reasonable assurance that there are at least three separate generations of D. brevicomis in the Bass Lake area. We know also that most of the overwintering brood stages are larvae which develop to adults and emerge during the latter part of May. To reconstruct events on this basis, here is approximately what happened:

First Seasonal Generation, 1944.

Adults emerged from scattered trees in the Bass Lake area during May and were attracted to the blowdown material, some of them flying in for a distance of several miles. The beetles were too few in number to attack more than a small portion of the total number of downed logs, but were successful in establishing large broods. Within 6 to 8 weeks these broods developed to maturity and the adults emerged, presumably during the early part of August 1944.

Second Seasonal Generation, 1944.

The first seasonal generation of adults did not have to fly far among the unattacked windfalls in which to establish the second generation attack. This attack was much larger than the first because of the greater number of beetles emerging from the windfall material. Populations were greatly increased in this generation because of ideal breeding conditions. Second generation adults presumably began to emerge during the latter part of September 1944.

Third Seasonal (overwintering) Generation, 1944.

By this time a great increase in the number of attacking beetles had built up; in fact, there were more than enough to attack the remaining unattacked windfalls left following the second generation attack. Hence, attacks were made also among the living timber within the blowdown area; the number, however, was not large (about 25 trees in the 500-acre area). The overwintering generation was, therefore, partly harbored by the windfalls and partly by standing timber.

DEVELOPMENT OF EPIDEMIC CONDITIONS IN 1945.

First signs of greatly increased infestations in the Bass Lake area began to show up early in August 1945 at elevations ranging from 4,000 to 5,000 feet along Graham Ridge; in Chilcoot Creek and Upper North Fork of Willow Creek basins; and in the Sand and South Fork of Willow Creek basins, all within striking distance of the windfall area. The spread of these infestations to vigorous trees in large groups quite remote from the blowdown center at first did not seem to bear a close relation to the blowdown. Groups varying from 10 to 30 trees each were found, all in site II quality timber, much of it in cutover reserve stands. Most remote was an isolated group of 19 trees in the Nelder Grove area, approximately six miles from the center of the blowdown.

Very few windfalls were observed outside the McLeod Flat area. For this reason it is probable that in outlying areas within the general region of the blowdown they were relatively minor as a factor influencing attacks in sound timber. The attacks that were made indeed seemed to stem directly from the blowdown center.

Direction and distance of spread. (see map)

The direction of spread was probably influenced by the distribution of timber in a north-south direction. The ponderosa pine timber type extends only for short distances eastward and westward from McLeod Flat, hence the spread furthest in a north-south direction was to be expected.

The maximum distance of spread to the north as mentioned was in the Nelder Grove area six miles from the blowdown. The furthest extent southward was in timber due east of Manzanita Lake along the crest of South Fork Bluffs, which is about seven miles air line from the blowdown center. Eastward and westward the spread extended for approximately two miles from the center. Pine areas outside of the infested zones were relatively free from infestations.

Number of trees killed.

A red-top count was made in August 1945 following the fade of first generation trees. This count revealed a total number of 1,120 trees, of which 70 were sugar pines and 1,050 were ponderosa pines. The distribution as shown by the following tabulation and the map indicate how closely the infestation related to the blowdown.

Zone Number	Location	Acres	Number of trees killed	
			Total	Per Section
1	Blowdown area	600	250	266
2	0-1 mile from blowdown	3,840	245	41
3	1-2 miles from blowdown	7,680	258	22
4	2-3 miles from blowdown	8,320	111	9
5	3-4 miles from blowdown	6,400	102	10
6	4-5 miles from blowdown	7,040	94	8
7	5-6 miles from blowdown	5,760	60	7

As shown here, severe epidemic conditions existed within a three mile limit of the center of the blowdown area. Most intense killing was in the immediate area and diminished with distance away from the center.

Infestations beyond three miles to a distance of seven miles in a north-south direction were probably also influenced by the blowdown, especially those to the south along the north and east slopes of Goat Mountain and in South Fork of Willow Creek basin. This was indicated by concentrated killing in some areas and not in others which appeared to have been associated with topographic features of the area. The average kill beyond the three mile zone ranged from 7 to 10 trees per section. This is about twice the average kill per section in other parts of virgin and cutover pine on the Sierra National Forest as revealed by the 1945 annual forest insect survey. The average number of trees killed in measured samples on the Forest, amounting to a total number of six sections, was 4.8 trees per section.

CHARACTER OF D. BREVICOMIS ATTACKS. (Photos 1-4)

Attacks made by the western pine beetle on every tree among large numbers of trees examined indicated that populations of adults were unusually large. Attacks varied from 9 to 30 per square foot of bark area, and egg galleries were a close maze of tunnels. The resistance of most of the trees attacked was quickly overcome by the concentrated and concerted character of attacks made, even on trees with vigorous pointed crowns. Pitch tubes in most cases were numerous.

An idea of the populations which built up in the blowdown material can be gained from counts that were made of three representative square feet of bark from three of the windfalls. Each square foot sample contained over 250 exit holes and the average number for all samples was 270 holes. One can readily appreciate from this what populations were possible from an estimated 1500 or 2,000 trees which were blown over, each with bark areas ranging from 50 to 200 or more square feet which was suitable for the rearing of D. brevicomis broods.

THE ROLE OF IPS.

The part which Ips played in this infestation was conspicuous by its absence as a primary killer. Examinations made in this connection on six felled trees revealed Ips in four of them which filled in the tops lightly after the trees had been killed by D. brevicomis. In two cases no Ips work was present, one of which was a pole-sized tree 10 inches in diameter. This examination confirmed the belief that D. brevicomis was the principal insect involved as judged by the uniform fading among all trees killed.

ECONOMIC IMPORTANCE.

The importance of mass windfalls in contributing to an up-build of infestations as exemplified by the McLeod Flat blowdown cannot be overemphasized. This is just one more example of what happens if these trees are left in the woods. Where blowdowns are within easy access of logging, the logs should be removed within three to six months. If they cannot be logged, then the cost of treating them to prevent emergence of broods will be justified in the saving of timber that is certain to be killed later. At the time they occur, blowdowns should be regarded as menacing to living timber and as much of an emergency as a developing epidemic and should be treated as such.

INFESTATION OF D. BREVICOMIS IN 1945
RESULTING FROM MCLEOD FLAT BLOWDOWN
SIERRA NATIONAL FOREST

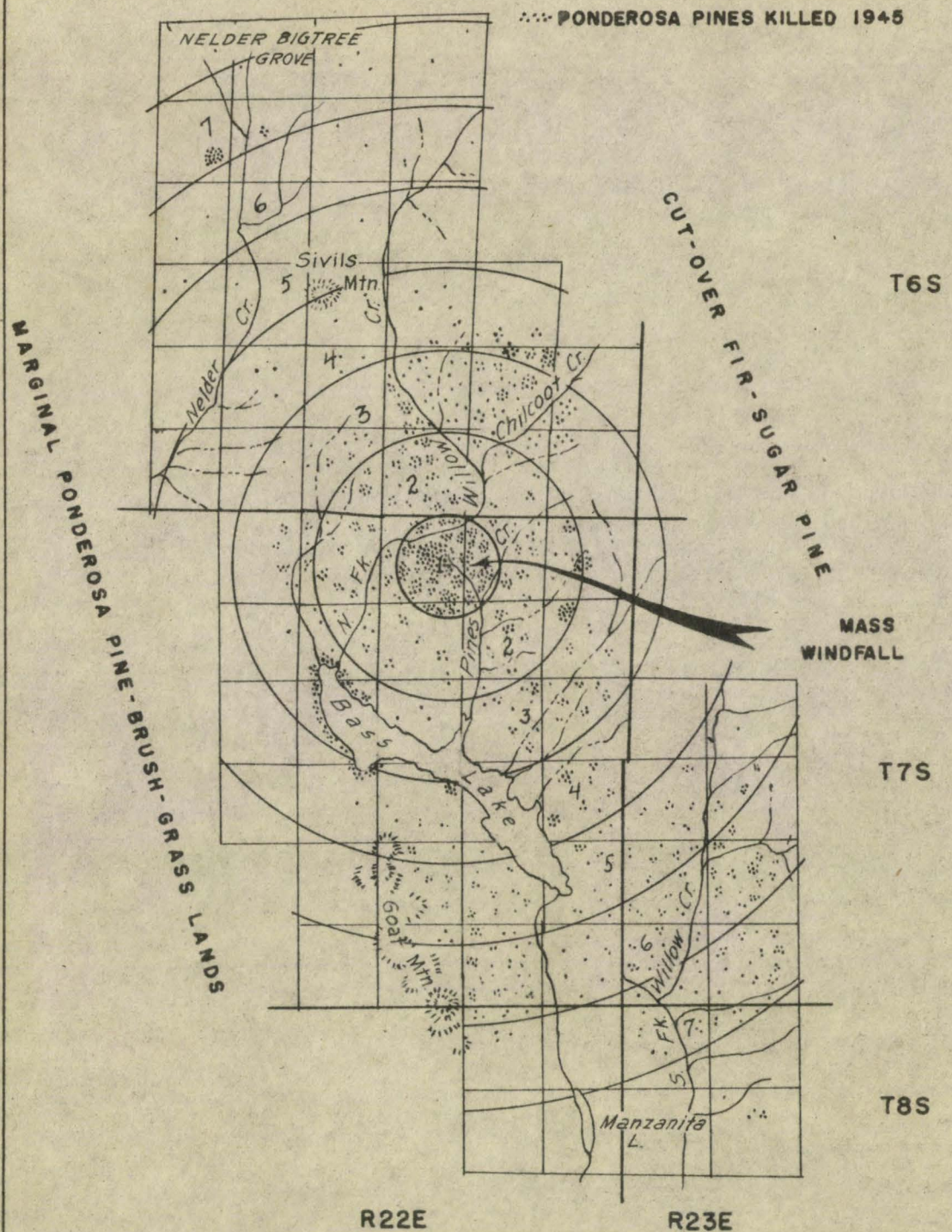

Photo #1 (13241). Group of 19 ponderosa pines killed by D. brevicomis in August 1945 near Helder Grove, six miles northwest of blowdown center. Note the vigorous character of these trees.

Photo #2 (13242). Bark removed from infested tree, exposing D. brevicomis egg galleries on sapwood surface. Every tree attacked contained a close maze of tunnels as shown here.

Photo #3 (13239). Numerous pitch tubes of D. brevicomis on bark of ponderosa pine. Heavy concentration of tubes as shown were typical of the aggressive 1945 attacks.

Photo #4 (13240). Part of a fifty-tree group killed by D. brevicomis in 1945 within McLeod Flat blowdown area. Some of the blowdowns here were salvaged.